Multicomponent Schrödinger cat states in ion traps

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We investigate quantum dynamical properties of a trapped three level ion interacting with two laser beams in λ-configuration. A unitary transformation method is developed to study the interaction of the ion with its vibrational phonons, quanta of ion's own center-of-mass motion. Under certain conditions on laser parameters, this interaction is shown to be unitarily equivalent to two phonon cascade transitions. Complicated temporal behaviors of level populations and mean number of phonons are described clearly by identifying dynamical variables of the cascade model as building blocks. Furthermore, analyzing quantum states of vibrational phonons by Husimi Q function, we find that at times determined by the underlying cascade dynamics, two and three component Schrödinger catlike macroscopic quantum superposition states can be obtained depending on the Lamb-Dicke parameter and the initial conditions of the system. A wide range of initial conditions and experimental parameters are discussed using both exact and analytical solutions. Alternative routes to reach the target states are found.